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14. ABSTRACT
The JCID S&T Insertion Project (JSP) is a team effort between a group at Penn State's Applied Research Lab and Lattice/RTI of Herndon, VA to integrate a flexible table-based sensor configuration capability into the the JCID/JWARN architecture. Using a reduced set of essential JCID requirements, we successfully implemented the JSP on several COTS PXA-type microprocessors. This is very important as it demonstrates software portability and readiness for future spiral development options. We also implemented data compression of JCAD plasmagrams and demonstrated moving that data through JWARN and displaying the uncompressed plasmagram on the C2PC. The JSP is moving forward with a sensor-embedded design for

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Report Title

JCID Thin Server/JSP Final Report

ABSTRACT

The JCID S&T Insertion Project (JSP) is a team effort between a group at Penn State's Applied Research Lab and Lattice/RTI of Herndon, VA to integrate a flexible table-based sensor configuration capability into the the JCID/JWARN architecture. Using a reduced set of essential JCID requirements, we successfully implemented the JSP on several COTS PXA-type microprocessors. This is very important as it demonstrates software portability and readiness for future spiral development options. We also implemented data compression of JCAD plasmagrams and demonstrated moving that data through JWARN and displaying the uncompressed plasmagram on the C2PC. The JSP is moving forward with a sensor-embedded design for future sensors and a small "dongle design that that fits the JSP into the cable between the radio/network connection and the sensor.

List of papers submitted or published that acknowledge ARO support during this reporting period. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Number of Papers published in peer-reviewed journals: 0.00

(b) Papers published in non-peer-reviewed journals or in conference proceedings (N/A for none)

Number of Papers published in non peer-reviewed journals: 0.00

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Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

1. D. Swanson, "JCID Thin Server," NDIA CBIS Conference, Austin, TX, Jan 8-11, 2007.

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Number of Manuscripts: 0.00

Number of Inventions:

Graduate Students

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Post Doctorates

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME	PERCENT_SUPPORTED	National Academy Member
David C. Swanson	0.25	No
Daniel Merdes	0.05	No
FTE Equivalent:	**0.30**	
Total Number:	**2**	

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period:	0.00
The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:......	0.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:......	0.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):......	0.00
Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:......	0.00
The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense	0.00
The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:......	0.00

Names of Personnel receiving masters degrees

NAME
Total Number:

Names of personnel receiving PHDs

NAME
Total Number:

Names of other research staff

NAME	PERCENT_SUPPORTED	
Mark Turner	0.20	No
Nathan Lasut	0.25	No
Robert Ceschini	0.50	No
FTE Equivalent:	**0.95**	
Total Number:	**3**	

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Inventions (DD882)

Final Report to ARO

JCID Compliant Thin Server for Sensors

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Statement of Problem

The JWARN Component Interface Device (JCID) is an electronic box which allows legacy chemical, biological, radiological, and nuclear (CBRN) sensors to be networked on the battlefield and feed XML formatted data into JWARN. The JCID met thousands of requirements from the many entities involved in JWARN, but the program evolved revealing logistical concerns, unnecessary requirements, and the need for greater flexibility in configuring JCIDs for new sensors. The "JCID Compliant Thin Server for Sensors" project provided a new technique for abstracting sensor interfaces to easily configurable files and command scripts.

Summary

At the beginning of the project in the Fall of 2006, the government expressed an interest in merging the "JCID Thin Server (JTS)" project with the "JCID-on-a-Chip (JoaC)" project performed by Lattice/RTI, Inc., of Herndon, VA. The JoaC project was tasked with review all the JCID requirements and down select to an appropriate subset for a device that could be embedded into a new sensor for JWARN. This way one could have the sensors used in JWARN fully compatible as they are manufactured. It would be very desirable for the JoaC to have as well the JTS configuration files as well as other XML performance enhancements and it would save effort to have JTS and JoaC work together. A technology transition agreement (TTA) was negotiated with the performers in agreement and signed in August of 2007[1]. The joint program was called the "JCID S&T Project" or JSP.

JSP prototype A commercial-off-the-shelf (COTS) processor based development prototype for the JSP was constructed which contained an improved battery, a FIPS compliance 3ETI radio, integral GPS, and the minimum required connectors for the JCID. The JSP development prototype was about the same size as the original JCID and was used in JWARN testing and evaluation (T&E). The JSP software was developed generically so it could be compiled to run

on several COTS processors. A common choice is the PXA-type processor which is about the size of a credit card, but is literally equivalent to a high-performance desktop PC from a few years ago. Initial T&E concerns were mainly from synchronization to the latest version of JWARN software and XML schemas. The major step forward from the JSP prototype is that the JSP is no longer tied to a specific hardware platform and now can be managed easily for future spiral developments of improved COTS processor technologies. The JSP can be reconfigured for new sensors without re-compiling the software in almost all cases. The JSP prototype box is seen in Figure 1.

Figure 1 The JSP prototype with the unit turned on showing 2 RS232 "Com" ports, Ethernet, a pair of alarm signal binding posts (top), GPS receiver (black disk on top), a pair of whip antennaes, and a provision for external 12 DV power. The 2nd switch (off) separately powers the 3ETI radio.

<u>XML Enhancements</u> Given a high performance JSP one of the urgent priorities was to demonstrate a significant enhancement beyond the existing JCID performance. We used the plasmagram output from a JCAD (Smith's detection LCD-3 ion mobility spectrometer) as a target to show what we could do with the JSP software. Plasmagrams are the chemical ion charge patterns detected in a chemically functionalized drift tube with a high electric field. There is a positive mode plasmagram and a negative mode plasmagram, and for the JCAD, each plasmagram contains 1024 data numbers. The plotted peaks in the plasmagrams are associated with a particular chemical in the instrument's library and pattern recognition algorithm. Why do we want to read this raw data? Even the well-tested JCAD has false alarm concerns and

performance problems with chemical mixtures. Analysis of the plasmagram details behind the JWARN firewall offers the potential for analysis beyond what the enemy has access to. Also, one can co-locate additional "orthogonal" sensors to capture other aspects of the chemical sample, such as the infrared spectrum, for data fusion behind the JWARN firewall[2].

We demonstrated moving JCAD plasmagram data to the C2PC via an "Event" attribute field called "details" left un-enumerated in the JCID schema. This is not the recommend way to move this data, but allowed us to adhere to the JCID schema. The JSP does this by mapping the sensor parameter to an element in an XML template file, and then pushing the file across to the C2PC. We also created a new data type called "compressed data" which defined 4 numbers for each plasmagram peak. Since there are only about 3 to 4 peaks for a given chemical plasmagram, the data compression is about 250:1. The compressed data type is listed in the JSP (via JTS) command definition and parameter definition files as a new data type with an associated function call, which processes the compression and maps the result to the XML file template. The compression algorithm can be applied to spectral peaks or dips of any type, including biological sensors and infrared sensors. The methodology also defines how one could add libraries of local JSP processing algorithms and map the results to XML message elements of any type, including CCSI formats. Figure 2 shows the differences on a linear scale between the full plasmagrams and compressed plasmagrams for clear air (only the reaction ion peak is seen in each plot).

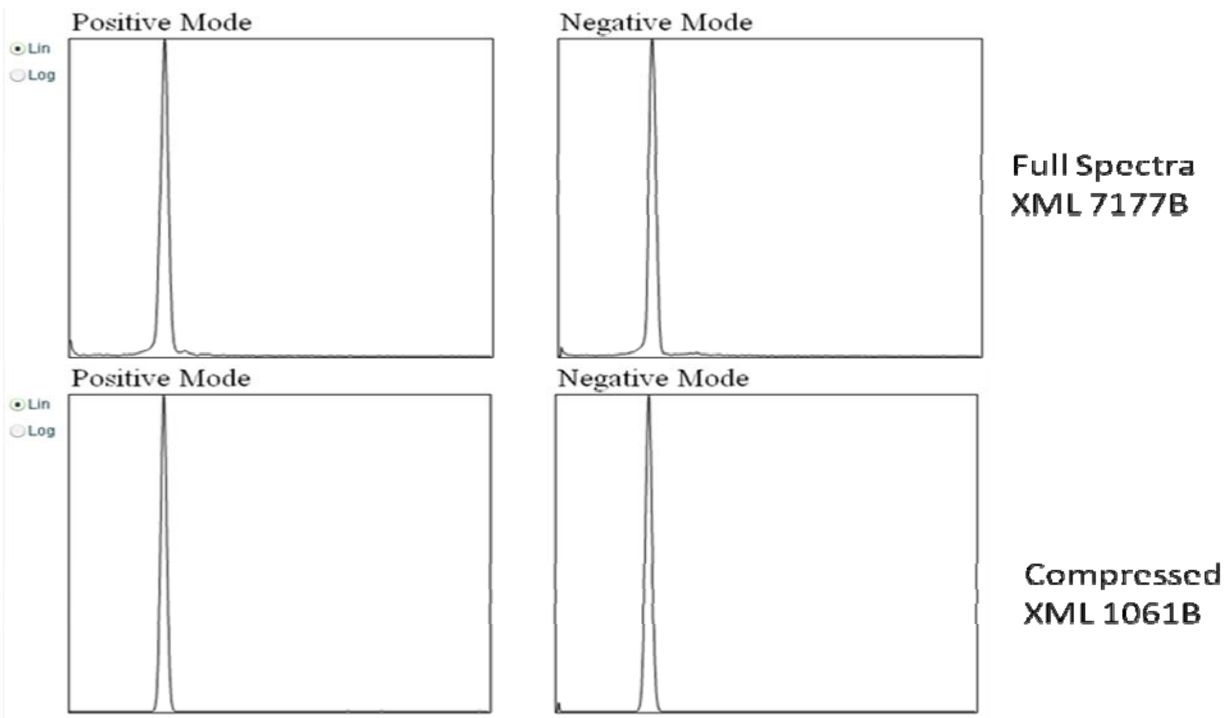

Figure 2 The original full plasmagrams from a JCAD for clean air (top) and the corresponding compressed plasmagrams (bottom) showing an overall 7:1 compression savings in the XML message (right) size due to the rest of the JCID Alarm XML message requiring about 1k bytes.

On the C2PC side, we implemented a web page to display and uncompress the plasmagram using "Flash Script" – a new standard for web browsers. The Flash script draws the graphs of the plasmagrams by loading the XML pushed to the C2PC and then continually updates the page with live graphics. The Flash Script and the XML files must be on the same domain (PC) as a security requirement built into Flash, so the script just becomes a display interface for the XML, and only the XML is updated. This is a very easy to use toolset for the JWARN-side of the system.

Dongle Prototype While the JSP prototype was meant for T&E and development purposes, its size presents an encumbrance for the user similar to the original JCID. A flexible but small device is needed to support S&T experiments and show a solution for legacy sensors to be used in JWARN (those with JoaC embedded within). The "Dongle" concept is to build the JSP into the cable between the sensor and the radio as a means to minimize logistical concerns. For S&T development, the JSP Dongle is approximately 0.5" x 2" x 6" with connectors on either end. A military hardened version would be a little "brick" with a cable out each end with a MIL-spec connector to mate with the radio and a different MIL-spec connector to mate with the specific sensor(s) in use. Figure 3 shows the JSP Dongle form factor and the various input and output capabilities of the design (this work is on-going at the time of this report writing).

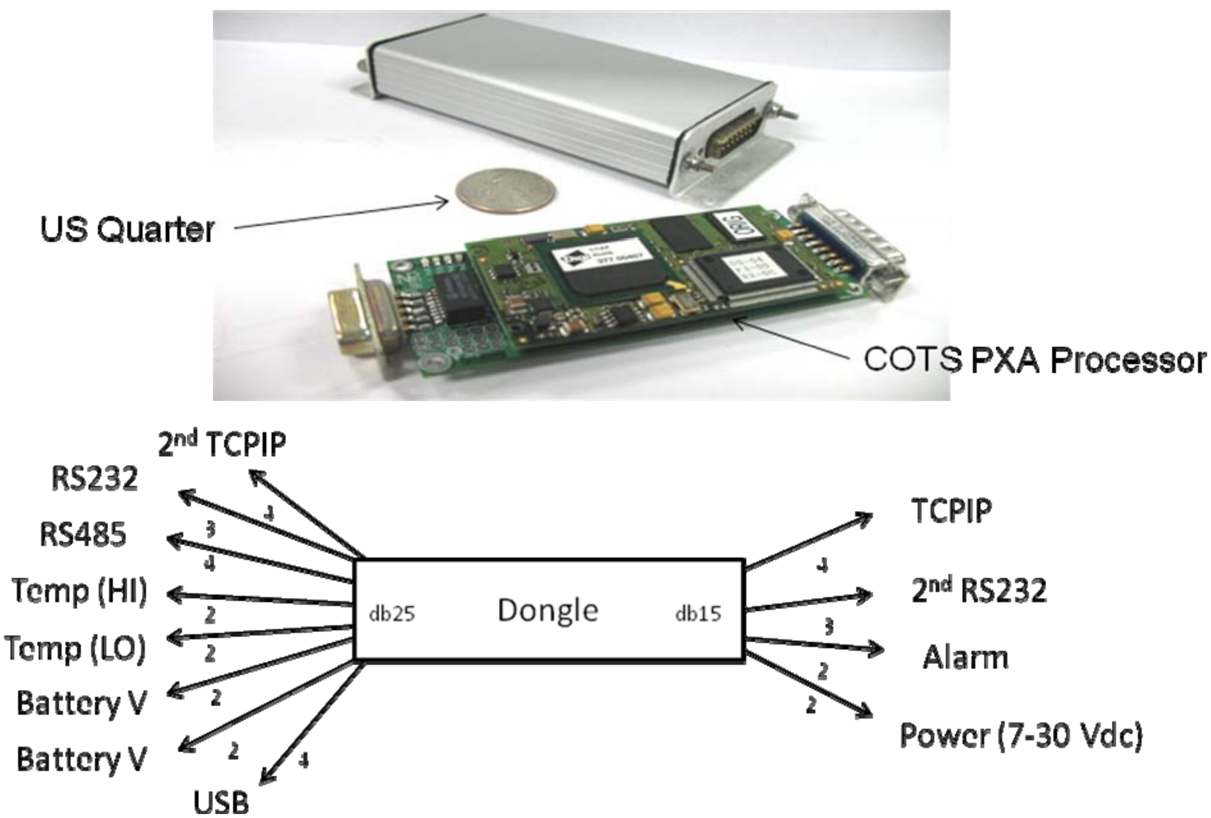

Figure 3 The JSP Dongle "lives in the cable" between the JWARN sensors and the radio or network connection and is based on a COTS PXA processor capable of a broad range of connectivity and advanced file services. The numbers near each arrow indicate the number of data lines needed.

Unlike the JSP prototype which implemented minimum JCID requirements, the JSP Dongle adds a few available features already in the COTS PXA processors such as a universal serial bus (USB) port, and RS485 control network port, 4 analog input lines, and a 2nd serial port. Note that the addition of a USB port also allows one to add a USB hub for multiple USB devices, which also include USB RS232 ports, making the JSP dongle extremely flexible for development work. All of these features are very useful and only require fabricating a "carrier board" for the particular PXA processor selected to bring out the appropriate electrical connections. The JSP Dongle features an integral weather sensor, GPS, compass, and tilt sensors via the RS485 port and a COTS weather sensor package developed for sailboat racing. The 4 analog inputs allow vertical gradients in air temperature to be measured as well as 2 battery voltages. The second RS232 port is a convenient setup port and can provide a standard output for jitters radios or Iridium satellite modems.

The RS485 port deserves some discussion of the details appropriate to JWARN. RS485 is a serial port protocol which allows multiple sensors or devices to be connected to the same serial cable. The 4th line on the RS485 arrow in Figure 3 is used to select the device being addressed. For JWARN, we found an excellent use for this available RS485 port in a COTS weather sensor which contains a compass, GPS, ultrasonic wind anemometer, tilt sensor, and barometer called the PB200 (cost approx $1500), made by AirMar Technology Corporation of Milford, NH. Similar weather stations are also available on the market and have been developed mainly for the sailboat racing markets. The sensor system provides very accurate wind speed and direction measurement with update rates faster than 1 second, which is faster than most CBRN sensors. They compensate for the course movement of the sailboat (via GPS) and the dynamic movements of the mast due to waves and provide a true and apparent wind heading and speed. This technology is perfect for a ground vehicle-borne JWARN sensor group with a JSP dongle managing the data and interface to JWARN. The surface meteorology data is not only essential to real-time JEM updates, but also to associating the wind direction during a CBRN sensor alarm to the source direction. Turbulence outdoors will naturally cause agent concentrations to fluctuate, but if one associates the instantaneous wind direction during a CBRN sensor detection and averages these over a few detections the source direction can be estimated.

We also add a pair of air temperature sensors to the JSP dongle seen in Figure 3 as “Temp (HI)” and Temp (LO)”. These measure the vertical temperature gradient which is important to how air parcels near the ground move vertically. During a hot day the air close to the surface is much hotter, more buoyant, and thus moves upwards. But during a clear night with little wind the opposite is true, creating a local surface weather condition capable of trapping and hold a CBRN threat near the ground. The movement of these cold air patches will be slow and tend to proceed downhill. This is called a Katabatic wind and its direction has nothing to do with the expected prevailing wind direction. This is why a weather sensor with very accurate low-speed wind measurement and temperature gradient capability is needed co-located with the CBRN sensors. Note that these are accurate to speeds below 1 mph, which is about 17.6 inches per second, and barely perceptible by a human. Figure 4 shows the AirMar weather sensor and the pair of air temperature sensors we plan to use. Each device is about 10 cm in size and multiple COTS sources are available. The air temperature sensors are under $300 each. The JSP Dongle can handle all the necessary data processing and provide detailed XML files for downloading my JEM and in support of detailed sensor data during an alarm event, for example using CCSI XML messages.

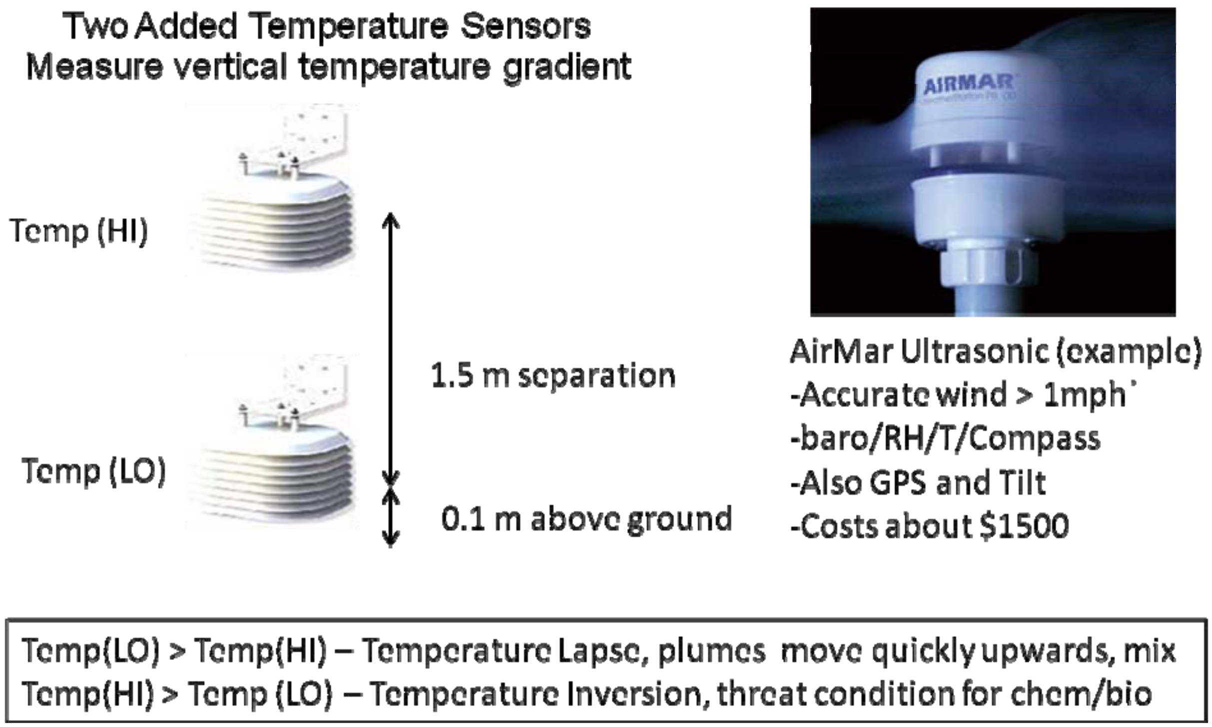

Figure 4 The ultrasonic anemometer (upper right) and pair of temperature sensors (left) are used to support JEM and provide detailed local environmental readings during a CBRN alarm. The anemomter also includes a built in GPS, compass, and tilt motion sensor.

Going forward, the JSP Dongle is a bridge device for JWARN S&T experiments and system development. We should also note that some PXA processors also offer a CAN (Control Area Network) bus port, which is common for military vehicles with digital sensors, engine controls, and digital subsystems. The CAN bus, also known as "OBDII" (On-Board Diagnostics) is part of most modern automobiles and trucks currently being manufactured. This suggests that a JSP dongle could easily migrate into the military logistics environment and provide mobile survey data of the environment and background agents throughout the theater of operations. The National Weather Service has been doing something similar with commercial trucking in the continental US for over a decade with great economic success. But the challenge in any large system of automated sensor networks is how does one move the data securely and efficiently and in a way that the using applications can find and exploit the information in a timely manner.

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[1] SPAWAR code 246207, "Technology Transition of JCID-on-a-Chip (JoaC) and JCID This Server (JTS) to PM, Joint Warning and Reporting Network, (JWARN) Block II," CO06MSB005, TTAIS021, Aug 9, 2007.
[2] D. Swanson, "JCID Thin Server," NDIA CBIS Conference, Austin, TX, Jan 2007.